

MECHANICAL ENGINEER

SURFACE SHIP SHOCK MODELING AND SIMULATION: EXTENDED INVESTIGATION

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Surface Ship Shock trials play an essential role in ship test and evaluation (T&E), and Live Fire Test and Evaluation (LFT&E) requirements for the lead ship of each new construction shock hardened ship class. These tests provide insight into platform vulnerabilities with respect to close proximity underwater explosion (UNDEX) events, and produce significant decision-making data for corrective action. The high cost of conducting ship shock trials has lead to a significant effort to develop modeling and simulation capabilities that can provide decision-making data comparable to that gained from the actual tests. Unfortunately, efforts to capture the response of a ship's structure to an UNDEX event require extremely large and complex finite element models of not only the ship's structure but the surrounding fluid. This fluid volume is required to capture the effects of the cavitation caused by the UNDEX shock waves. The computational expense of running these finite element models is tremendous. This thesis reviews the work on this subject completed at the Naval Postgraduate School. Additionally, it provides further investigation into the amount of the fluid that must be modeled to accurately capture the structural response of a 3D finite element model and presents a second generation finite element model of the USS JOHN PAUL JONES (DDG 53) for use in 3D analysis.

DoD KEY TECHNOLOGY AREAS: Battlespace Environments, Computing and Software, Conventional Weapons, Surface/Under Surface Vehicles-Ships and Watercraft, Modeling and Simulation

KEYWORDS: Underwater Explosion, Shock and Vibration

PRODUCTION OF ULTRA-FINE GRAINS AND EVOLUTION OF GRAIN BOUNDARIES DURING SEVERE PLASTIC DEFORMATION OF ALUMINUM AND ITS ALLOYS

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Equal channel-angular pressing (ECAP) is a recently developed method for deformation processing of material that can produce an ultra-fine grain structure in bulk material through severe plastic deformation. This study will present results on microstructural evolution during repetitive ECAP of pure aluminum. The principal method of data collection was Orientation Imaging Microscopy (OIM). The results of the study indicate that, after one ECAP pass, the structure is inhomogeneous and anisotropic, and consists mostly of deformation-induced features. After repetitive ECAP, the aluminum material exhibited a homogeneous grain size but retained an anisotropic character to the microstructure. After twelve ECAP passes the microstructure consisted mainly of fine grains surrounded by high-angle boundaries but an appreciable fraction of low-angle boundaries remained. This microstructure thus comprises a mixture of deformation-induced and recrystallization features. Further results were also obtained documenting the existence of deformation banding in this material as well as in a rolled aluminum alloy. This phenomenon may be general in nature and associated with severe plastic deformation in aluminum and its alloys.

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